ENEE 630: ADVANCED DIGITAL SIGNAL PROCESSING
Fall 2013: Monday and Wednesday, 3:30pm - 4:45pm
Class Room: EGR 1108

Instructor: Dr. Vishal M. Patel
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References:
P.P. Vaidynathan, Multirate Systems and Filter Banks, Prentice-Hall, 1993
Additional readings of relevant technical publications will be announced in class.

Prerequisites: ENEE 425 or equivalent undergraduate DSP course; and co-requisite ENEE620 or equivalent probability and random process course (graduate-level).

Assignments: There will be approximately ten homework assignments and two projects. The projects involve the use of programming and simulation tools such as Matlab or C/C++. Instructions and deadlines will be given as each assignment is announced.

Recitations:
Tuesday 5:00pm - 5:50pm
Room: KEB 1200
During recitations your TA will go over solutions to selected problems. In addition, recitations provide you with an opportunity to ask clarifying questions regarding material or concepts presented in lecture. The style of the recitations will be rather interactive, so your participation is both encouraged and important.

Exams: There will be a mid-term exam during the semester and a comprehensive final exam. All exams will be closed book. The exact material to be covered on each exam will be announced about one week before the exam date.

Course Grade:
Assignments: 35%
Mid-term: 30% Mid October
Final Exam: 35% Wednesday, Dec. 18, 2013 (1:30pm-3:30pm)

Academic Honesty: Students are expected to follow university guidelines.

Disabilities: If you have a disability, you should contact Dr. Patel at your earliest convenience.
COURSE OUTLINE

1. Multirate Signal Processing
   (Chapter 2, 4, 5 of Vaidynathan; see also Proc. IEEE 90 tutorial paper by Vaidynathan)
   - Decimation and interpolation; sampling rate conversion; direct-form and polyphase representation.
   - Time-varying filter structures; implementation of DFT filter banks; multistage implementation of sampling-rate conversion.
   - Quadrature mirror filter (QMF) bank; M-channel filter banks; multiresolution filter banks.
   - Perfect reconstruction systems; aliasing-free filter banks.
   - Multi-resolution analysis, wavelets.
   - Compressive sampling

2. Parametric Signal Modeling and Linear Prediction Theory
   (Chapter 13 of Haykin 4th ed.; see also Chapter 47 of Hayes)
   - Stochastic time-series models: AR, MA, ARMA; Wold decomposition.
   - Discrete Wiener filters: principle of orthogonality, normal equations.
   - Linear prediction theory: forward and backward linear predictions and their properties.
   - Levinson-Durbin algorithm; lattice prediction filter; joint-process estimation.

3. Spectral Estimation
   (Chapter 8 of Hayes; see also relevant discussions in Haykin)
   - Nonparametric methods: periodograms and windowing methods; statistical properties; minimum-variance spectral estimation.
   - Parametric methods: AR, MA, and ARMA spectral estimation; maximum entropy method.
   - High-resolution techniques.

4. Advanced topics (if time permits)
   - Frame theory: Naimark theorem, finite frames, frames and filter banks.
   - Time-frequency distributions: STFT, Wigner-Ville distribution, Cohen’s class of time-frequency distributions.
   - Linear and non-linear approximation.